
खुले कुएँ के लिए निमज्जनीय
पम्पसेट — विशिष्टि
(पहला पुनरीक्षण)

Openwell Submersible Pumpsets
— Specification
(First Revision)

ICS 23.100.10

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pumps Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

This standard was first published in 1994. Experience gained in implementation of this standard necessitates this revision and certain changes that are necessary have been incorporated. In this revision, all amendments have been reviewed and incorporated and due importance has been given to energy conservation and safety.

Following important changes are made in this revision:

- a) Additional constructional features for the motor and the rotor of the wet type submersible motor,
- b) Additional design features for shaft, replaceable bearing and wearing ring,
- c) Detailed general requirements for different components used in the pump,
- d) Additional tests on submersible motor, that is 'leakage current test' etc; and
- e) Information to be furnished by the purchaser.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

OPENWELL SUBMERSIBLE PUMPSETS — SPECIFICATION

(*First Revision*)

1 SCOPE

This standard specifies the requirements for submersible pumpsets (single/multi-stage) using single/three phase a.c. induction motor commonly used in openwells for handling clear, cold water for application in agriculture, domestic and water supply purposes.

2 REFERENCES

The standards listed at Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 UNITS

3.1 Units relating to submersible pumps as specified in **2** of IS 5120 shall be applicable.

4 TERMINOLOGY

4.1 Terminology relating to pumps as specified in **3** of IS 5120 shall be applicable. In addition, following terminology shall also apply:

4.1.1 *Draw Down* — Difference in water level below static water depth, caused by running of the pump.

4.1.2 *Static Water Depth* — Depth of water level below the ground level, when the pump is not working.

4.1.3 *Submergence* — Height of water level above the top of the suction casing, while running.

4.1.4 *Characteristics of Clear, Cold Water*

Clear cold water shall mean, water having the characteristics specified below:

- | | |
|--|-----------------------------------|
| 1) Turbidity | 50 ppm (Silica Scale), <i>Max</i> |
| 2) Chlorides | 500 ppm, <i>Max</i> |
| 3) Total solids | 3 000 ppm, <i>Max</i> |
| 4) pH | 6.5 to 8.5 |
| 5) Temperature | 33°C, <i>Max</i> |
| 6) Specific gravity | 1.004, <i>Max</i> |
| 7) Hardness (as CaCO ₃),
(drinking water) | 300 mg, <i>Max</i> |

NOTES

1 If the range of pH value of water pumped is between 6.5 and 7.5 and also the chloride content is less than 100 ppm, the bronze components of pump may be made of any grade of bronze. However, if the range of pH is between 6.5 and 8.5, and the chloride content exceeds 100 ppm, only zinc free bronze fitted construction or stainless steel fitted construction, shall be permitted.

2 If any characteristics of the water differ from those specified in **4**, the pump details shall have to be agreed between the manufacturer/supplier and user and shall be specified in the order.

5 CLASSIFICATION

Classification relating to pumps shall be as specified in **6** of IS 5120 and for motors as specified in IS 1885 (Part 35), IS 9283 and IS 14582 as applicable.

6 NOMENCLATURE

Nomenclature of the parts commonly used in openwell submersible pumpsets shall be given in Fig. 1, Fig. 2 and Fig. 3.

7 CONSTRUCTIONAL FEATURES

7.1 Material of Construction

It is recognized that a number of materials of construction are available to meet the needs for pumps handling clear, cold water. A few typical materials are indicated in Table 1 merely for guidance to the manufacturer and the user.

7.2 Gaskets, Seals and Packings

Gaskets, seals and packings used for clear, cold water pumps shall conform to the applicable requirements specified in **5.2** of IS 5120.

7.3 The motor shall be provided with a breathing attachment like bellows, diaphragm etc; to compensate the volumetric variation of water inside the motor due to change in the temperature.

7.4 The motor shall be protected from ingress of well water, sand and other foreign matter by means of cable glands, rubber seals etc.

7.5 All materials and components for the motor shall be suitable for application in respect of resistance and mechanical performance continuously under water.

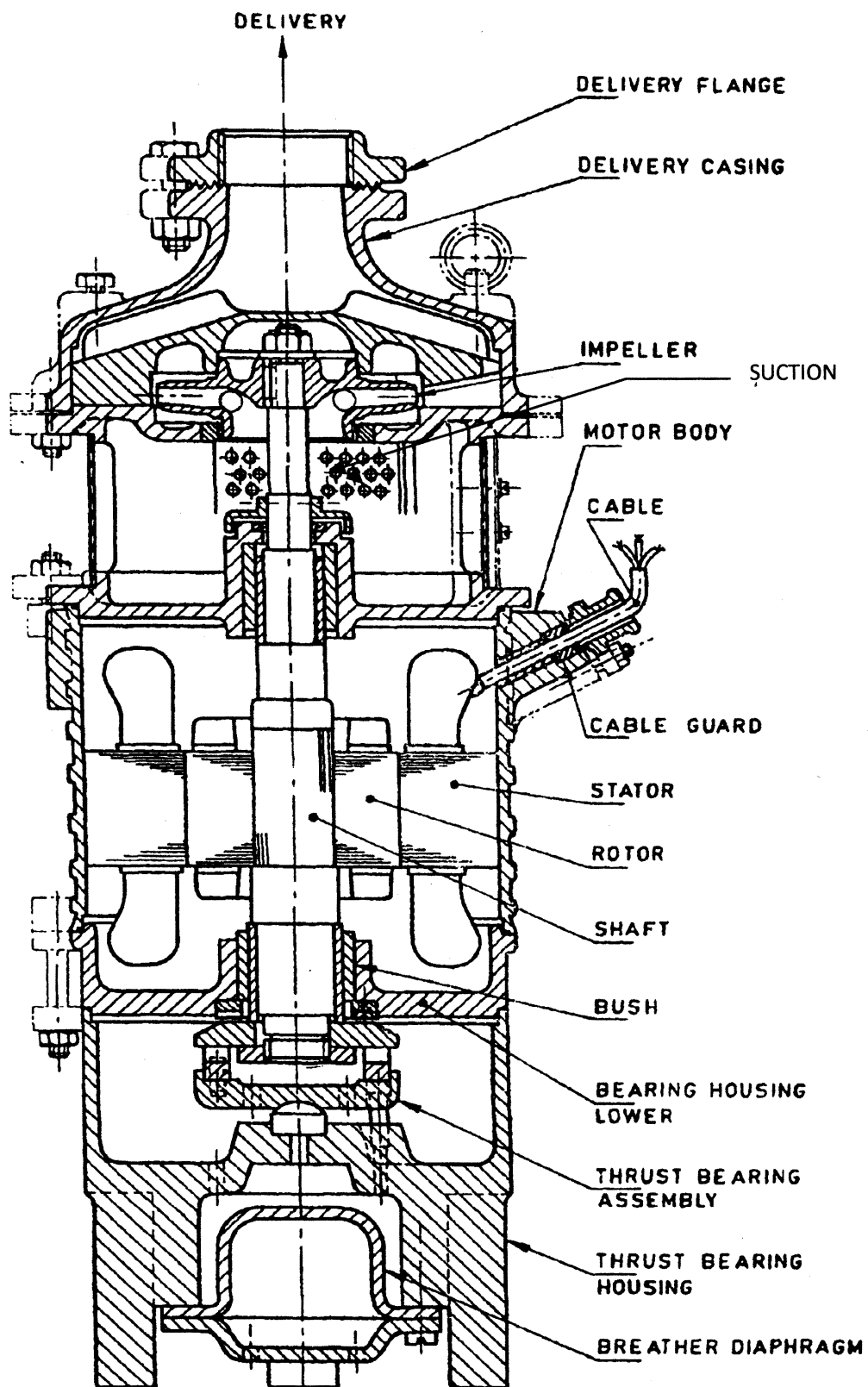


FIG. 1 NOMENCLATURE OF VERTICAL SINGLE STAGE OPEN WELL SUBMERSIBLE PUMPSET (TYPICAL)

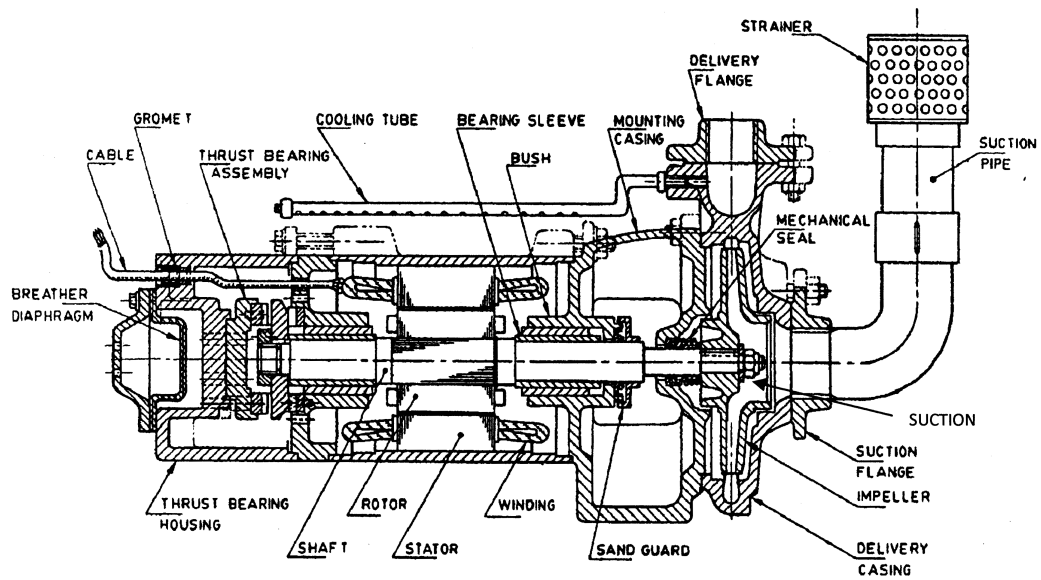


FIG. 2 NOMENCLATURE OF HORIZONTAL SINGLE STAGE OPEN WELL SUBMERSIBLE PUMPSET (TYPICAL)

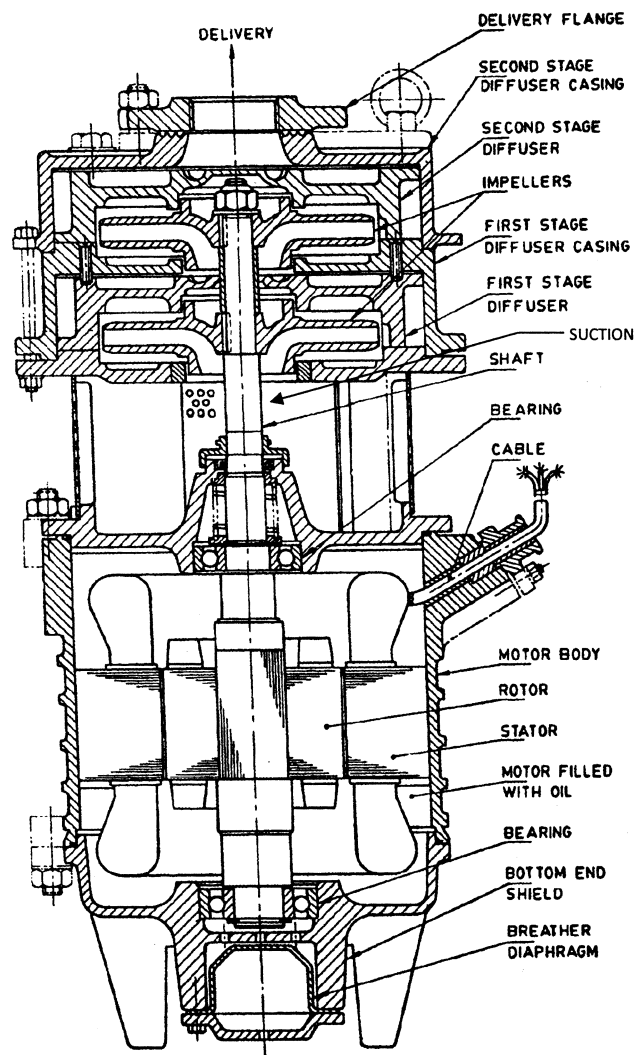


FIG. 3 NOMENCLATURE OF VERTICAL MULTI STAGE OPEN WELL SUBMERSIBLE PUMPSETS (TYPICAL)

7.6 The rotor of the wet type open well submersible motor and rotor in water filled designed motor shall be provided with suitable coating to protect it from corrosion under water. However if suitable anti-corrosion additive is added in the water, no separate protection on rotors is necessary.

8 DESIGN FEATURES

8.1 The pump shall have suitable features properly designed to ensure satisfactory performance. In particular, the following design features shall be incorporated:

8.1.1 The inlet passages of the suction casing shall be streamlined to avoid eddies.

8.1.2 The multi-stage pump shaft may be guided through bearings, the bearings may be provided in stage casing, suction housing and discharge casing, while in case of intermediate bearings, suitable positions may be selected in the overall span.

8.1.3 The pump may be equipped with replaceable bearing and wearing ring, wherever provided.

8.1.4 The strainer on the suction shall offer the best compromise amongst restraining large solids from entering the pump and containing the suction losses to the minimum.

8.1.5 The pump shall be capable to give discharge without overloading the prime mover within the permissible current at rated voltage and supply frequency at minimum +5 percent and minimum -15 percent of the guaranteed duty point head up to 30 m. Above 30 m, the pump shall be capable to give discharge without overloading the prime mover within the permissible current at rated voltage and supply frequency at minimum +10 percent and minimum -25 percent of the guaranteed duty point head.

8.1.6 The motor shall be of continuous duty as specified in IS/IEC 60034-1.

8.2 Voltage and Frequency Variation

8.2.1 Open well submersible motor shall be capable of operating at the supply voltage and frequency for Category "A" or Category "B" specified below:

8.2.1.1 Category 'A'

The motors shall be capable of delivering rated output with:

- a) the terminal voltage differing from this rated value by not more than ± 6 percent ;
- b) the frequency differing from its rated value by not more than ± 3 percent; and
- c) any combination of (a) and (b).

8.2.1.2 Category 'B'

The motor shall be capable of delivering rated output with

- a) the terminal voltage differing from this rated value by not more +6 percent and -15 percent;
- b) the frequency differing from its rated value by not more than ± 3 percent; and
- c) any combination of (a) and (b).

8.2.2 The manufacturer shall have a system of controlling dimensional accuracy within a scheme of fits and tolerance. The system shall help interchangeability and fitment at site for replacement spares during repair and maintenance.

9 EFFICIENCY

9.1 The pump efficiency of open well submersible pumps at duty point as declared by the manufacturer for 4 and 2-poles shall not be less than given in Fig. 5, Fig. 6 and Fig. 7 and beyond this range, the efficiency shall be declared by the manufacturer. To arrive at the overall efficiency of the pumpset, follow the points given under Notes of Fig. 5, Fig. 6 and Fig. 7.

10 GENERAL REQUIREMENTS

10.1 The general requirements for the pump shall be as specified and applicable as per 17 of IS 5120 and for motor shall be as given in IS 9283.

10.2 Casing

10.2.1 Pump casing shall be of robust construction and shall be tested to withstand hydrostatic pressure test as specified in 15.5.

10.3 Impeller

10.3.1 The impeller may be of enclosed or semi-open type.

10.4 Shaft

10.4.1 The shaft shall be of adequate size to transmit the required power.

10.4.2 The surface finish of the shaft or of the protecting sleeve of the pumpsets having journal bearings shall be $0.75 R_{a, Max}$ (see IS 3073). Suitable sealing arrangement to be made to avoid contamination of pumped fluid with filled fluid.

10.5 Balancing

10.5.1 In case of 2-pole open well submersible pumpset, the impeller and rotor shall be dynamically balanced to balance quality grade G 6.3 of IS/ISO 1940-1 : 2003.

10.5.2 In case of 4-pole open well submersible pumpset, the impeller shall be statically or dynamically

balanced and rotor shall be dynamically balanced to Balance quality grade G 6.3 of IS/ISO 1940-1 : 2003.

10.5.3 The plastic impeller need not be balanced.

10.5.4 Balancing here means the balancing of the unbalanced rotating mass in the impeller and not balancing of the axial hydraulic thrust in the impeller.

10.6 Provision for Earthing

10.6.1 Earthing of the motor shall be done as per IS 9283 in accordance with the relevant provisions of IS 3043.

10.6.2 For safety purpose it shall be ensured during installation that the earthing is capable of taking care of leakage current.

10.6.3 In case of PVC pipes used as discharge pipe, a separate non-corrosive, low resistance conductor from motor earth terminal to control panel earth terminal shall be provided for earthing.

10.6.4 In case of non-corrosive GI pipes and clamps are used for the purpose of earthing the motor, earthing connection may be made to the discharge pipe clamp and to the control panel earth terminal.

10.7 Terminal Marking and Direction of Rotation

10.7.1 Terminal markings shall be in accordance with IS 9283.

10.7.2 The direction of rotation of pumpset is designated clockwise or anti-clockwise as observed when looking at the pump shaft from the driving end.

10.7.3 The direction of rotation shall be clearly and securely marked by incorporating an arrow on the pumpset.

11 DIMENSIONS AND TOLERANCES

11.1 Since the openwell submersible pumpsets are meant for use in open wells only. The overall dimensional and tolerance requirement is at the discretion of the manufacturer.

12 CABLE

12.1 Flat/Round cables (3/4 core type) insulated and sheathed with suitable polymer as per IS 694 shall be used.

12.1.2 The size of the conductor shall be adequate and suitable for continuous use under water and in air. The length of the cable shall be minimum 2 m from outside the motor unless otherwise specified by the customer.

12.1.3 The size of the conductor and the length of cable should be suitably selected so that the voltage drop between the control panel and the motor terminal does not exceed 3 percent of the rated voltage.

12.1.4 In case of a joint is required to be made between the lead cable supplied with the motor and the user's cable, a detailed procedure to make water tight joining shall be supplied by the motor manufacturer.

12.1.5 If four core cable is used, the fourth core shall be used for earthing.

13 OPEN WELL SUBMERSIBLE MOTOR

13.1 Single Phase Motors

13.1.1 Rated Voltage and Rated Frequency

The preferred rated voltage and frequency shall be 240 V and 50 Hz respectively.

13.1.2 Motor designed for operation at voltages other than 240 V shall be considered as complying with this standard provided they comply in all respects except full load current (maximum), which shall be changed in inverse proportion of the voltage.

13.1.3 Ratings

The preferred output ratings of the motors for open well pumpsets shall be 0.37, 0.55, 0.75, 1.1, 1.5 and 2.2 kW.

NOTE — Rating above 2.2 kW may be as declared by the manufacturer.

13.1.4 Types of Motors

Single phase Squirrel cage induction motors are as follows:

- a) Capacitor Start and Run motor (CSR);
- b) Capacitor Start and Capacitor Run motor (CSCR); and
- c) Capacitor Start Induction Run motor (CSIR).

13.2 Three Phase Motors

13.2.1 Rated Voltage and Rated Frequency

The preferred rated voltage and frequency shall be 415 V and 50 Hz respectively.

13.2.2 Motor designed for operation at voltages other than 415 V shall be considered as complying with this standard provided they comply in all respects except full load current (maximum), which shall be changed in inverse proportion of the voltage.

13.2.3 Ratings

The preferred output ratings of the motors for openwell pumpsets shall be 0.37, 0.55, 0.75, 1.1, 1.5, 2.2, 3.7, 5.5, 7.5, 9.3, 11 15, 18.5 and 22 kW.

NOTE — Rating above 22 kW may be as declared by the manufacturer.

13.2.4 Type of Motor

Three phase squirrel cage induction motor.

13.3 Speed

The preferred synchronous speed for 2 or 4 pole motors shall correspond to 3 000 rpm or 1 500 rpm respectively.

14 TEST FOR ELECTRICAL PERFORMANCE ON MOTOR FOR OPEN WELL SUBMERSIBLE PUMPSET

14.1 General

14.1.1 Submersible motors shall conform to all the requirements of IS 9283. However, in case of pumpset, motor need not be tested for full load test [16.1(g)], Performance characteristics [16.1(h)], momentary overload test [16.1(m)] as per IS 9283.

The temperature rise tests shall be conducted as per 14.6. The general requirements of the motor with regard to site conditions, voltage and frequency, type of enclosures, methods of cooling, materials, duty-rating, terminal marking and earthing shall be in accordance with IS 9283.

14.1.2 While conducting routine and type tests on open well submersible motor for electrical performance, supply voltage shall be the rated voltage and frequency shall be within ± 3 percent of rated frequency.

14.1.3 In case of three-phase openwell submersible motor, the value of the current (amperes) shall be the average value of current (amperes) measured in all the three phases.

14.1.4 Performance characteristic values of 4 pole openwell submersible motors shall be as declared by the manufacturer.

14.1.5 Performance characteristic values of 2 pole three-phase openwell submersible motors of less than 1.1 kW and exceeding 22 kW rating shall be as declared by the manufacturer.

14.1.6 However for three-phase openwell submersible motors above 22 kW rating, the declared value of efficiency shall not be lesser than 22 kW value.

14.1.7 Performance values of single phase openwell submersible motors of other ratings below 0.37 kW and exceeding 2.2 kW shall be declared by the manufacturer.

14.1.8 However for single phase openwell submersible motors above 2.2 kW rating, the declared value of efficiency shall not be lesser than 2.2 kW value.

14.1.9 However, in case of pumpset, motor need not be tested for full load test.

14.2 Electrical Measurement

For voltage, current, power and frequency measurement, instruments of adequate capacity shall be used.

14.3 Insulation Resistance Test

Insulation resistance tests shall be as per IS 9283.

14.4 High Voltage Test

High voltage test shall be as per IS 9283.

14.5 Leakage Current Test

The maximum leakage current value shall be not more than 50 milli ampere at rated voltage at no load. The motor shall be placed on either a rubber mat or a wooden base or any other insulated base. A voltage equal to rated voltage shall be applied to any supply line and accessible outside metal parts of the motor. The resistance of the test circuit shall be $2\,000 \pm 50$ ohms.

14.6 Temperature Rise Test

14.6.1 The temperature rise test at reduced voltage shall not be applicable for category 'A' open-well submersible motors.

14.6.2 For conducting temperature rise test, the pump itself shall be used for loading the motor.

14.6.3 During the tests the water temperature shall not exceed 45°C.

14.6.4 Temperature rise test for winding shall be carried out on the sample pumpset:

- a) at rated voltage and supply frequency within ± 3 percent of rated frequency, and
- b) at 85 percent of rated voltage and supply frequency within ± 3 percent of rated frequency.

14.6.5 Temperature Rise Test at Rated Voltage

14.6.5.1 Set the load for the observed maximum current in the specified operating head range of the electric monoset at the rated voltage and supply frequency and run the pumpset for 2 h. Stop the pumpset and measure the winding resistance and water temperature within 30 s.

Temperature rise computed by resistance method shall not exceed 35°C.

14.6.6 Temperature Rise Test at Reduced Voltage

The test shall be carried out within 5 min after temperature rise test at rated voltage. The pumpset shall run at maximum current in the specified operating head range at rated voltage. After reducing the voltage to 85 percent of rated voltage, in this condition, run the pumpset for 1 h. Stop the pumpset and measure the winding resistance and water temperature within 30 s.

Temperature rise computed by resistance method shall not exceed 45°C.

14.6.7 Determination of Temperature Rise of Winding by Resistance Method

The temperature rise ($t_2 - t_1$) may be obtained from the ratio of the resistance by the following formula:

$$[(t_2 + 235) / (t_1 + 235)] = R_2 / R_1$$

where

- t_a = temperature (°C) of external cooling medium (water) at the end of the test,
- t_2 = temperature (°C) of the winding at the end of the test,
- R_2 = resistance of the winding at the end of the test,
- t_1 = temperature (°C) of the winding (cold) at the moment of the initial resistance measurement, and
- R_1 = initial resistance of the winding (cold).

For practical purposes, the following alternative formula may be found convenient:

$$(t_2 - t_a) = (R_2 - R_1) / R_1 * (235 + t_1) + (t_1 - t_a)$$

14.6.8 For the purpose of calculation of temperature rise at reduced voltage, the value of R_1 shall be taken as the value measured at cold condition.

14.7 Breakaway (Starting) Torque Test

14.7.1 The minimum value of breakaway (starting) torque as percentage of rated torque, with the rated voltage and frequency applied across the terminals shall be as given in Table 2 for three phase motors and in Table 3 for single phase motors.

14.7.2 The readings of the input current, power and breakaway torque shall be determined. This test may be done at a suitable reduced voltage.

14.8 Rated Speed

14.8.1 The rated speed (minimum) for two pole motors shall be as given in Table 2 for three-phase motors and in Table 3 for single phase motors.

14.8.2 The rated speed (minimum) for four pole motors shall be declared by the manufacturers.

14.8.3 The speed shall be measured as per IS 9283.

14.9 Routine Test

14.9.1 Following shall constitute the routine test for electrical performance on open well submersible motor as per IS 9283.

- a) Insulation resistance test (before high voltage test only);
- b) High voltage test;
- c) No load running of motor and reading of current, voltage, power and speed;

- d) Locked rotor reading of voltage, current and power input; and
- e) Reduced voltage running up test at no load to check the ability of the motor to run up to full speed on no load with 60 percent of the rated voltage applied to the motor for three phase motors and 75 percent of the rated voltage applied to the motor for single phase motors.

14.9.2 Locked rotor test may be done at a reduced voltage, when a current at least equivalent to rated load current is being taken by the motor.

14.9.3 The requirements and values shall be in accordance with those specified in IS 9283 as may be applicable.

14.10 Type Test

14.10.1 Following shall constitute the type test for electrical performance on open well submersible motor as per IS 9283.

- a) Insulation resistance test (both before and after the high voltage test);
- b) High voltage test;
- c) Measurement of stator resistance;
- d) No load running of motor and reading of voltage current, power input and speed;
- e) Reduced voltage running up test at no load to check the ability of the motor to run up to rated speed on no load with 60 percent of the rated voltage applied to the motor for three-phase motors and 75 percent of the rated voltage applied to the motor for single phase motors;
- f) Locked rotor reading of voltage, current and power input and torque of motors;
- g) Breakaway (starting) torque;
- h) Leakage current test;
- j) Temperature rise test at rated voltage; and
- k) Temperature rise test at reduced voltage;

14.10.2 Locked rotor test may be done at a reduced voltage, when a current at least equivalent to rated load current is being taken by the motor.

14.10.3 Temperature rise test however shall be done as per 14.6.

14.10.4 The requirements and values shall be in accordance with those specified in IS 9283 as applicable.

15 TEST FOR HYDRAULIC PERFORMANCE ON PUMP FOR OPEN WELL SUBMERSIBLE PUMPSET

15.1 Sampling

The sampling and criteria of conformity for hydraulic

performance shall be as per IS 10572, except for lot size up to 25. The sample for lot size up to 25 shall be as below.

<i>Lot Size</i>	<i>Sample Size</i>
Up to 7	1
8 to 15	2
16 to 25	3

15.2 Laboratory Tests

Testing procedures as given in IS 11346 shall be followed and a typical testing arrangement for open well submersible pumpset is given in Fig. 4.

15.3 Head Measurement

15.3.1 *Measurement of Total Head* (see Fig. 3 of IS 11346)

The total head is made up of:

- Vertical distance between pumping water level to gauge centre distance in metres (Z);
- Delivery gauge reading in metres in water column (h) and
- Velocity head in metres ($vd^2/2g$).

Therefore, Total head $H = Z + h + vd^2/2g$.

15.4 Flow Measurement

15.4.1 Measurement of flow shall be as specified in IS 11346.

15.5 Hydrostatic Pressure Test

Hydrostatic pressure test shall be carried out on individual part or pump as a whole in assembled condition at 1.5 times the maximum pressure and this pressure shall be maintained for 2 min and no leakage shall be observed.

16 GUARANTEE AND TOLERANCES ON OPENWELL SUBMERSIBLE PUMPSET PERFORMANCE

16.1 Guarantee of Performance

16.1.1 The pumpset shall be guaranteed for their performance of the nominal volume rate of flow and the nominal head at the guaranteed duty point. The overall efficiency of the pumpset shall be guaranteed at the declared duty point only.

16.1.2 The guarantee shall be deemed to have been met with, if the measured values of head, volume rate of flow and overall efficiency are within the limits indicated in IS 11346. However, after applying the tolerance, overall efficiency value shall not be less than that derived from Fig. 5, Fig. 6 and Fig. 7.

16.1.3 Open well submersible motor shall not get overloaded in the specified operating head range at rated voltage and supply frequency.

16.1.4 The pump shall be tested for the operating head range as per **8.1.5**.

16.1.5 The overloading of motor is that condition when maximum current drawn by the motor exceeds the limit of 1.07 times of the rated motor current.

16.1.6 The tolerance shall apply to guaranteed duty point only.

16.1.7 Performance at rated voltage and supply frequency is actual performance of the set. This is better than performance at rated speed, since in the entire operating head range speed of motor is higher than rated speed, as motor is running in under loaded condition.

16.1.8 The manufacturer shall specify the minimum submergence of pump unit at duty point.

16.2 Head and Discharge

16.2.1 Pump performance shall be declared at the rated voltage and rated frequency. Following affinity laws shall be applied for correction of performance at rated frequency.

- Discharge (Q) $\propto f$
- Head (H) $\propto f^2$
- Power (P) $\propto f^3$

(where f = supply frequency)

16.2.2 The pumpset shall be guaranteed at the nominal duty point. The same pumpset may also deemed to have met the guarantee if the new duty point lies within the specified tolerance of head (± 4 percent) and discharge (± 7 percent) of nominal duty point and meets all other pump performance characteristics specified.

16.3 Current

16.3.1 The rated current of motor (maximum) as given in Table 2 for three-phase motors and in Table 3 for single phase motors for the applicable motor rating.

16.3.2 The rated current of motor (maximum) is given in the corresponding table for the applicable motor rating are for the preferred rated voltage only. For other voltages, it shall be in inverse proportion to the preferred rated voltage.

16.3.3 Manufacturer shall declare the rated current of motor less than or equal to the rated current (maximum) of motor as given in the corresponding table for the applicable motor rating.

16.3.4 To arrive the permissible limit of current (maximum) in the operating head range at rated voltage for checking the non-overloading requirement in the

operating head range of the pumpset, the rated current of motor (maximum) at rated voltage as given in the corresponding table for the applicable motor rating multiply by 1.07.

16.3.5 For other voltages, the permissible limit of current (maximum) in the operating head range shall be in inverse proportion to the preferred rated voltage.

16.3.6 In the case of lesser value declaration on the rated current of motor (maximum) by the manufacturer, 7 percent plus tolerance on the declared rated current of motor (maximum) shall be allowed for arrive the permissible limit of current (maximum) in the operating head range for checking the non overloading requirement in the operating head range.

16.4 Pump Efficiency

16.4.1 The pump efficiency (minimum) in Fig. 5, Fig. 6 and Fig. 7 represents three stages and above:

- For two stage pump, multiply pump efficiency (minimum) given by a factor 0.98.
- For single stage pump, multiply pump efficiency (minimum) given by a factor 0.97.

16.5 Overall efficiency

16.5.1 For arriving overall efficiency percentage (minimum) of the pumpset, multiply pump efficiency (minimum) value by motor efficiency factor.

16.5.2 The motor efficiency factor as given in the Table 2 for three phase 2 pole motors, Table 3 for single phase 2 pole motors and Table 4 for three phase 4 pole motors, for the corresponding motor rating.

16.5.3 A superior value of overall efficiency at declared duty head per stage and discharge value may be declared by the manufacturer, and applicable tolerance shall be applied. After applying the tolerances, it should meet the minimum overall efficiency requirements.

16.5.4 Overall efficiency, $\eta_{ov} = (H \times Q) / (102 \times \text{Input to motor})$ where H = Total head in metres of water column, Q = discharge in lps and input power in kW.

16.5.5 The tolerance value for overall efficiency (minimum) $\eta_{ov} = 0.955 \times \eta_{ovg}$.

where

η_{ov} = overall efficiency (minimum) and

η_{ovg} = overall efficiency guaranteed.

16.6 Verification of Guarantee

16.6.1 The pumpset shall be guaranteed at specified duty point as per 8.1, 8.2 and 8.3 of IS 11346, for the following:

- Rate of flow,
- Total head,
- Current, and
- Overall efficiency for electric openwell submersible pumpsets.

16.6.2 If the guaranteed duty point lies below the tested graph, pump shall be deemed to have conformed to the head and discharge requirements provided the prime mover is not over loaded in the declared operating head range.

16.6.3 If the guaranteed points lie above the tested graph then vertical distance (H) and horizontal distance (Q) are found from the pumpset tested values plotted in the graph and the following shall be evaluated:

$(H_G \times X_H / \Delta H)^2 + (Q_G \times X_Q / \Delta Q)^2 \geq 1$, where XQ and XH are agreed tolerances applicable to Q and H respectively $XQ = 0.07$, $XH = 0.04$

Thus if the total amount is greater than or equal to 1.0, the guarantee condition shall be deemed to have been met and if total amount is less than 1.0, the guarantee condition has not been achieved.

16.7 Prime Mover Rating

16.7.1 To ensure the proper rating of the pumpset, the pumpset shall be tested at rated conditions and the current (maximum) consumption of the pumpset in the operating head range shall be verified. The actual verified current shall not be less than 75 percent of the maximum declared current at the rated voltage.

NOTE — The above clause is to ensure proper rating of pump set.

17 PERMISSIBLE INACCURACIES IN MEASUREMENTS

17.1 In all commercial acceptance tests for agricultural pumps, a certain tolerance shall be allowed to the manufacturer on his guarantee to cover the inaccuracies of the equations for volume rate of flow, errors of observation and unavoidable errors of the instruments employed.

17.1.2 The permissible inaccuracy in the measurement of various quantities and all pertinent apparatus used shall be as indicated in IS 11346.

17.1.3 However, measuring equipments with higher accuracy class may also be used.

18 MARKING AND PARAMETERS TO BE DECLARED BY THE MANUFACTURER

18.1 A nameplate of corrosion resistant material shall be affixed on the pumpsets with the following details:

- Motor rating (kW);
- Delivery size in mm;
- Type / Model;
- Type of motor — INDUCTION MOTOR — (*CSIR / CSCR / CSR*)
- Rated voltage with variations;

- f) Rated current;
- g) Rated Frequency;
- h) Rated speed;
- j) Number of phases;
- k) Category of Motor;
- m) Winding connection (STAR / DELTA / STAR-DELTA)
- n) Type of duty;
- p) Head in metres at declared duty point;
- q) Discharge at declared duty point;
- r) Overall efficiency at declared duty point;
- s) Operating head range;
- t) Number of stages;
- u) Minimum submergence;
- v) Manufacturer's name or trade-mark; and
- w) Serial number.

18.1.1 In the type of motor (*CSIR/ CSCR/CSR*) are applicable for single phase motor only.

18.1.2 In the winding connection (STAR/DELTA/STAR-DELTA) are applicable for three-phase motor only.

18.1.3 The manufacturer's brand name or logo shall be embossed or indented on the pumps casing.

19 INFORMATION TO BE FURNISHED BY THE PURCHASER

19.1 When enquiring or ordering pumps to this standard, the user may furnish the following information to the suppliers:

- a) Name of the purchaser;
- b) Address of the purchaser;
- c) Installation site;
- d) Number of pumps required;
- d) Spare parts required;
- e) Pump operating conditions:
 - 1) Capacity.....l/min, l/s or m³/h.
 - 2) Number of poles of motor.
 - 3) Total head, alternatively, sketch of the pipe line giving information, such as, static delivery pipe diameter and length, distance between point of discharge, pipe fittings and valves used, etc, may be given.
 - 4) Static water depth.
- f) Description of the well:
 - 1) Installation of the pump in openwell, others.
 - 2) Total depth of open well/deep well. Static water depth. Well developed to.... l/min at....metre draw-down.

- g) Site conditions:
 - 1) Height above mean sea level in metres, and
 - 2) Details of quality of water with respect to all the characteristics as given in 4.
- j) Power supply:
 - 1) Type of supply (single-phase / three-phase),
 - 2) Frequency (Hz),
 - 3) Voltage (V), and
 - 4) Variation in voltage/frequency.
- k) Accessories (state whether the following items are required):
 - 1) Sluice valve,
 - 2) Reflux valve,
 - 3) Pressure gauge,
 - 4) Rising main pipe and delivery bend / elbow,
 - 5) Type of installation stages in the entire system,
 - 6) Water level indicator,
 - 7) Voltage stabilizer,
 - 8) Automatic starting and stopping device (optional),
 - 9) Starter — direct on the line or star-delta or indicate starting method,
 - 10) Voltmeter,
 - 11) Ammeter,
 - 12) Single phasing preventers,
 - 13) Water level guard, and
 - 14) Low voltage protector.

NOTE — Serial No. 6 to 14 may be arranged in a separate control panel.

20 INSTALLATION

20.1 The pump shall be installed in accordance with the manufacturer's recommendation prescribed in the instruction manual which shall be supplied along with the pumpset.

21 BIS CERTIFICATION MARKING

21.1 The pumpsets may also be marked with BIS Standard Mark.

21.2 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder. The details of condition under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
210 : 2009	Grey iron castings (<i>fifth revision</i>)	1885 (Part 35) : 1993	Electro technical vocabulary: Part 35 Rotating machines
304 : 1981	High tensile brass ingots and castings	3043 : 1987	Code of practice for earthing
318 : 1981	Leaded tin bronze ingots and castings	3444 : 1999	Corrosion resistant alloy steel and nickel base castings for general applications
613 : 2000	Copper rods and bars for electrical purposes	5120 : 1977	Technical requirements for rotodynamic special purpose pumps
617 : 1994	Aluminum and aluminum alloy ingots and castings for general engineering purposes	8783 : 1978	PVC insulated winding wires for submersible motors for 85°C operation.
694 : 2010	Polyvinyl chloride insulated unsheathed — and sheathed cables/cords with rigid and — flexible conductor for rated voltages — up to and including 450/750 V	9283 : 2013	Motors for submersible pumpsets
		10572 : 1983	Methods of sampling for pumps
		11346 : 2002	Code of acceptance tests for agricultural and water supply pumps (<i>first revision</i>)
1570 (Part 2/Sec 1) : 1979	Schedules for wrought steels: Part 2 Carbon steels (unalloyed steels) Section 1 wrought products (other than wires) with specified chemical composition and related properties	IS/ISO 1940-1 : 2003	Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state Part 1 specifications and verification of balance tolerances
1570 (Part 5) : 1985	Schedule for wrought steels: Part 5 Stainless and heat resisting steels	IS/IEC 60034-1: 2004	Rotating electrical machines — Part 1 Rating and performance
1875 : 1992	Carbon steel billets, blooms, slabs and bars for forgings		

Table 1 Typical Materials for Components of Open Well Submersible Pumpset
(Clause 7.1)

Sl No (1)	Name of the part (2)	Material of Construction (3)
i)	Shaft Sleeve when used	Grade X04 Cr 12, X12 Cr 12 or X20 Cr 13 conforming to IS 1570 (Part 5)
ii)	Motor bearing housing and base	Grade FG 200 of IS 210
iii)	Motor shaft	Grade X04 Cr 12, X12 Cr 12 or X20 Cr 13 conforming to IS 1570 (Part 5) or Grade 40C8 or 45C8 conforming to IS 1570 (Part 2/Sec 1)
iv)	Bearing bush	Leaded tin bronze Grade LTB3, LTB4 or LTB5 of IS 318 or resin bonded carbon or PTFE bonded carbon
v)	Rotor	Electrical sheet steel conforms to IS 648 and electro grade copper rods conforming to IS 613 or Aluminium die cast rotor conforming to IS 617
vi)	Stator core	Electrical sheet steel and PVC insulated winding wire/polymer insulated winding wires or with any suitable plastic covered wires conforming to IS 8783
vii)	Winding wire	a) For water filled motors b) PVC insulated winding wire conforming to IS 8783 or c) With polymer insulation such that the test on insulation resistance satisfied.
viii)	Breather and diaphragm	Nitrile rubber
ix)	Cable	PVC insulated and PVC sheathed 3 core flat type conforming to IS 694 or PVC insulated polymer sheathed 3 core flat type
x)	Cable gland	Nitrile rubber
xi)	Thrust bearing face combinations	Bronze-ferro-asbestos, brass-ferro tests, carbon-stainless steel, bronze- suitable elastomer or any other suitable combinations
xii)	Water drain plug	Bronze/brass/stainless steel/suitable plastics
xiii)	Impeller	High tensile brass conforming to IS 304 or leaded tin Bronze LTB 2 of IS 318 or Cast iron FG 200 of IS 210 or suitable thermoplastics such as poly phenylene oxide (PPO), polycarbonate, acetal, glass filled nylon 6/nylon 66 PTFE, ABS, Polyester PETP, UHMWPE, etc
xiv)	Casing	Cast iron Grade FG 200 of IS 210, Alloy steel casting conforming to IS 3444

NOTE — The materials listed are to be considered as only typical and indicative of minimum requirements of the material properties. The use of materials having better properties is not prejudicial by the details above provided materials for components in bearing contact with each other do not entail galling, corrosion, magnetic induction, etc.

Table 2 Performance Characteristics Values for Three Phase Submersible Motors for Openwell Submersible Pumpset
(Clauses 14.7.1, 14.8.1, 16.3.1 and 16.5.2)
(415 Volt, 50Hz, 2-Pole, Water filled)

Sl No.	Motor Rating	Rated Current <i>Max</i>	Full load speed <i>Min</i>	Starting Torque (In terms of percentage of Full Load Torque) <i>Min</i>	Motor Efficiency Factor
(1)	(kW) (2)	(Amp) (4)	(rpm) (5)	(percent) (6)	(7)
i)	1.1	3.25	2740	125	57
ii)	1.5	4.5	2740	125	66
iii)	2.2	6.5	2760	125	69
iv)	3.0	8.5	2760	125	69
v)	3.7	10.0	2780	125	70
vi)	4.5	12.0	2780	125	72
vii)	5.5	14.5	2800	125	75
viii)	7.5	19.5	2800	125	76
ix)	9.3	25.0	2820	125	77
x)	11	29.0	2820	125	78
xi)	13	34.0	2840	125	79
xii)	15	39.0	2840	125	80
xiii)	18.5	48	2850	125	81
xiv)	22	57	2850	125	82

Table 3 Performance Characteristics Values for Single Phase Submersible Motors for Openwell Submersible Pumpset

(Clauses 14.7.1, 14.8.1, 16.3.1 and 16.5.2)

(240 Volt, 50Hz, 2-Pole, Water filled, Capacitor Start and Run (CSR), Capacitor Start and Capacitor Run (CSCR))

Sl No.	Motor Rating	Rated Current <i>Max</i>	Full load Speed <i>Min</i>	(CSR) Starting Torque (In terms of percentage of Full Load Torque) <i>Min</i>	(CSCR) Starting Torque (In terms of percentage of Full Load Torque) <i>Min</i>	Motor Efficiency Factor
(1)	(kW) (2)	(Amp) (4)	(rpm) (5)	(percent) (6)	(percent) (7)	(8)
i)	0.37	5.3	2700	30	125	40.0
ii)	0.55	6.2	2710	30	125	42.0
iii)	0.75	7.5	2720	30	125	46.0
iv)	1.1	10.5	2720	30	125	49.0
v)	1.5	13.8	2730	30	125	52.0
vi)	2.2	19.8	2740	30	125	56.0

Table 4 Performance Characteristics Values for Three-phase Submersible Motors for Openwell Submersible Pumpset

(Clause 16.5.2)

(415 Volt, 50Hz, 4-Pole, Water filled)

Sl No. (1)	Motor Rating, kW (2)	Motor Efficiency Factor (3)
i)	1.1	51.0
ii)	1.5	59.5
iii)	2.2	62.0
iv)	3.0	62.0
v)	3.7	63.0
vi)	4.5	65.0
vii)	5.5	67.5
viii)	7.5	68.5
ix)	9.3	69.5
x)	11.0	70.0
xi)	13.0	71.0
xii)	15.0	72.0

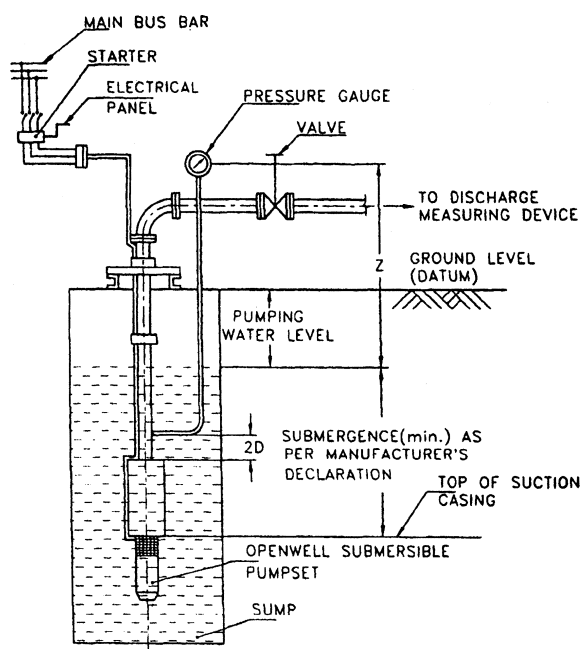


FIG. 4 TESTING ARRANGEMENT FOR OPENWELL SUBMERSIBLE PUMPSETS (TYPICAL)

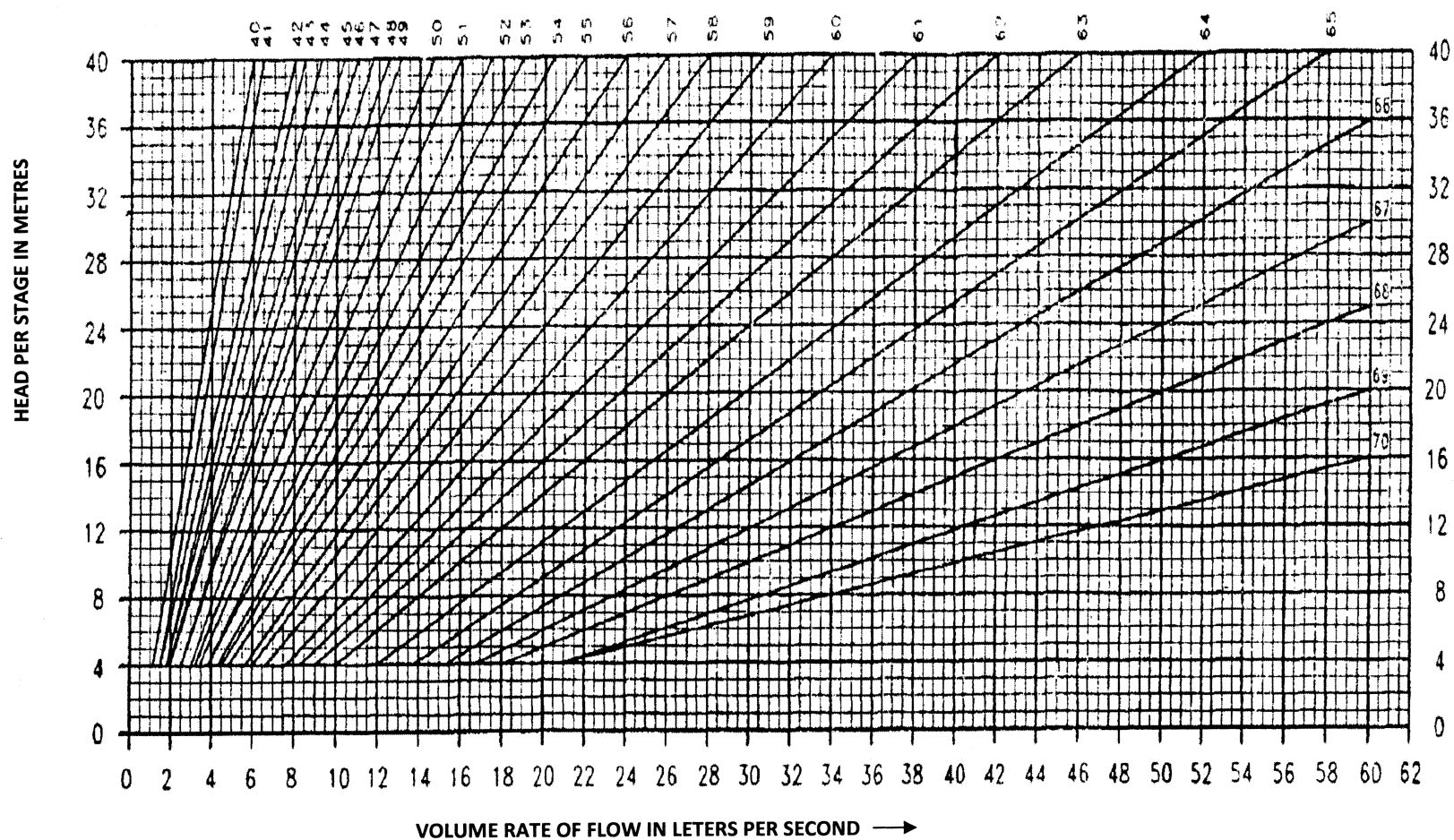


FIG. 5 GRAPH FOR PUMP EFFICIENCY (MINIMUM) FOR OPENWELL SUBMERSIBLE PUMPSETS OF 4 POLE 50 HZ

NOTES

- 1 For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given in Table 4.. No reduction shall be allowed at part loads.
- 2 The efficiency chart includes non-return valve.

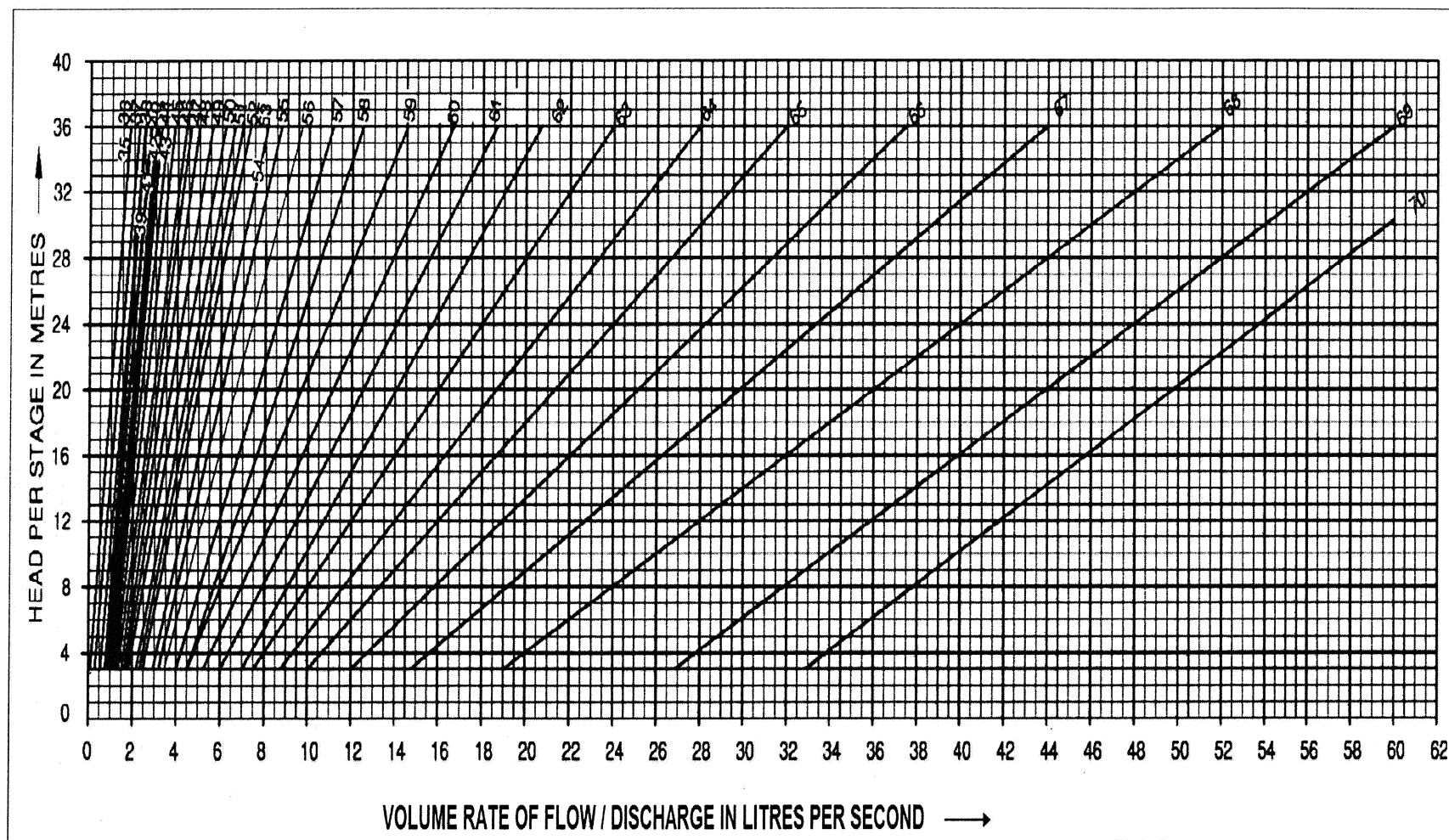


FIG. 6 GRAPH FOR PUMP EFFICIENCY (MINIMUM) FOR OPENWELL SUBMERSIBLE PUMPSETS OF 2 POLE 50 Hz—FOR ABOVE 5 LPS

NOTES

- 1 For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given in Tables 2 & 3 as applicable. No reduction shall be allowed at part loads.
- 2 The efficiency chart includes non-return valve.
- 3 Efficiency of the pumpsets having declared duty points beyond the efficiency lines on either side may be declared by the manufacturer and applicable tolerance shall apply. Where the point lies in between the efficiency lines, the higher value is taken as minimum efficiency.
- 4 for volume rate of flow below 5 litres per second, Fig. 7 shall be referred.

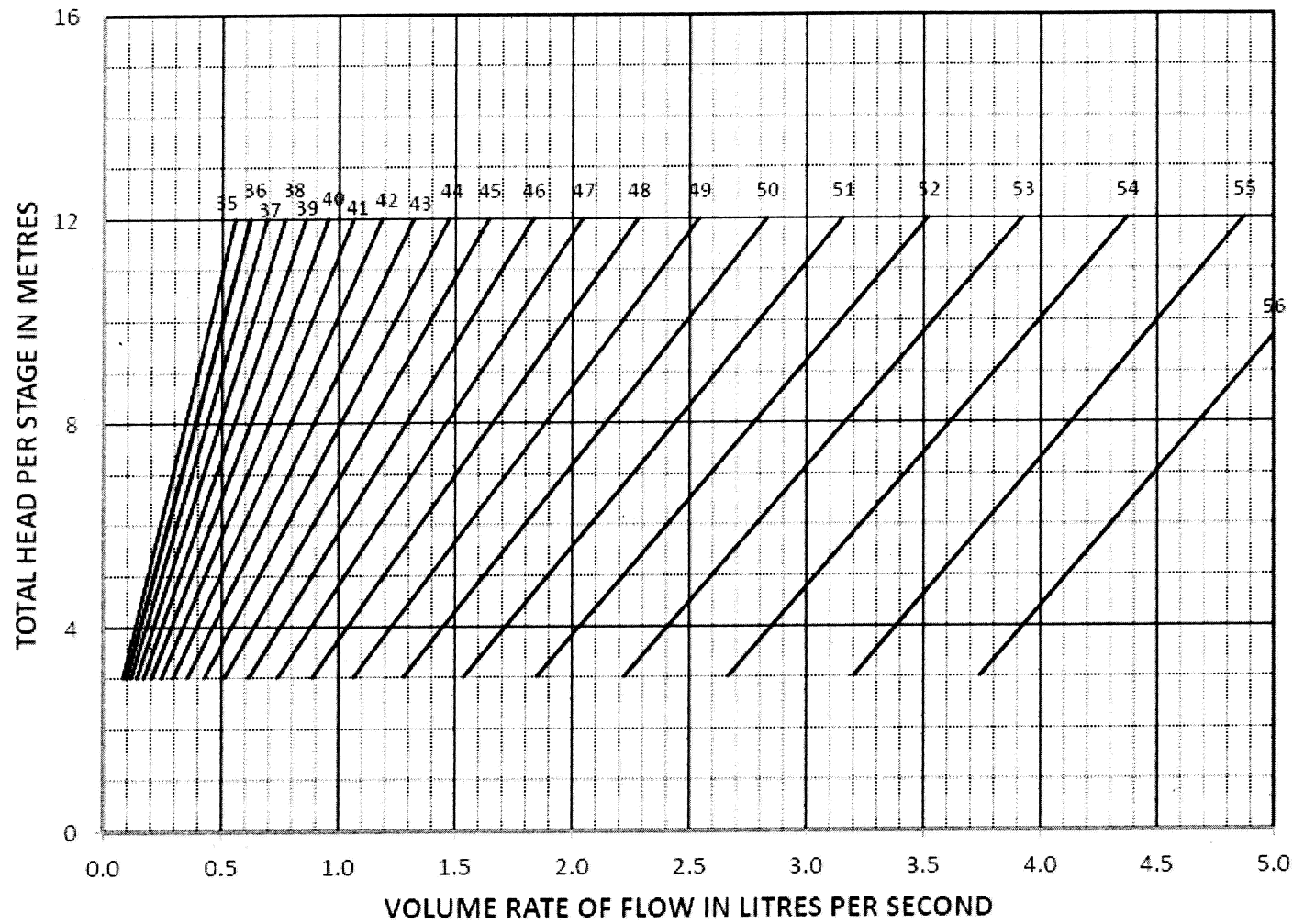


FIG. 7 GRAPH FOR PUMP EFFICIENCY (MINIMUM) FOR OPENWELL SUBMERSIBLE PUMPSETS OF 2 POLE 50 HZ—UPTO 5.0 LPS

NOTES

- 1 For overall efficiency of the pumpset, multiply pump efficiency by corresponding motor efficiency factor as given in Tables 2 & 3 as applicable. No reduction shall be allowed at part loads.
- 2 The efficiency chart includes non-return valve.
- 3 Efficiency of the pumpsets having declared duty points beyond the efficiency lines on either side may be declared by the manufacturer and applicable tolerance shall apply. Where the point lies in between the efficiency lines, the higher value is taken as minimum efficiency.
- 4 for volume rate of flow below 5 litres per second, Fig. 6 shall be referred.

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This Indian Standard has been developed from Doc No.: MED 20 (1319).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi